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REPORT NO.

TO LOCATION

Mr. A. M. Squires

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Br. R. L. Mecklin

DATE

March 1, 1946

HAT HATE ANSWERING LETTER DATE

U234 Performance

IN FIRES

Bear Mr. Souirest

The suggestion that the performance of a building be asserted for Uppl has been passed along for investigation. The use of sight counting for this purpose seems entirely feasible. Calculation of the equivalent U245 performance from that of Upak was not included in this investigation but a preliminary survey has not shown any fundamental difficulties provided scaplate recycle can be assured.

A mathed of coloulating the ratio of the weight fractions of U244 at two points such as the top and bottom of an incluted building is developed with particular attention to sinializing the error.

(ch U-231) At miterial will give smaller errors than any other. The reason may be roughly outlined as due to two factors in alpha counting. The higher the proportion of Upple the greater its contribution to the total alpha count and hence the more closely the alpha count will determine the proportion of Uzgi. On the other hand the higher the propertion of U214 the greater the alpha counting rate will be. As the preparation of UqQ films is restricted fairly closely to films from one to ten milligrams, the higher counting rates cannot be out down by using lighter films. As the uncertainty in the correction for resolving time of the alpha counters is about ten percent, the magnitude of the correction must be kept low. Bata obtained from Mr. Alesseens shows that an enrichment of U234 greater than five or six, makes this s correction error greater than the uncertainty in counting rate.

The alpha counting calculations and error estimates follow. To minimize instrument fluctuations samples should be rotated and several files, differing in weight used for each sample. By this means the self absorption and resolving time corrections can be determined for each scaple individually. The alpha counting rates thus obtained (by extrapolation of the rates on the several films for each sample) are bereinsfter designated by a and are expressed in counts per minute per milligram of Uzok film.

The counting rate A of each sample is composed of three parts representing the contribution of the three uranium isotopes.

> A # 4234 =234 # A235

Carbide and Carbon Chemicals Corporation, Operating Contractor for the U.S. Atomic Energy Commission.

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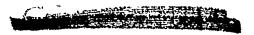
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(m represents the weight of oxide of each isotope in milligrams present in each milligram of Taba film)

The counting rates of each isotope (A23, A235 and A235) con be calculated for normal (feed) uranium from the measured isotope ratios and the relative activities of U235 and U235.

$$n_{234}^0 = 0.000059$$
 $n_{235}^0 = 0.00714$ $n_{238}^0 = 0.9928$

The relative activities of U235 and U235 in nature are stated to be as 0.046 to 1.

*Hier - Phys. Rev. 55, 150 (1939)

The International Table of Stable Isotopes for 1938 gives the isotopic - weights as 235.084 and 236.088. Assuming a weight of 234.0 for Uggi the weight fractions in natural urnains are then

$$\mathbf{a}_{231}^{\circ} = 0.000058$$
 $\mathbf{a}_{235}^{\circ} = 0.00705$

The activity of V23L and V298 in natural uranium is equal because of their redicactive equilibrium. Thus the fraction of the alpha activity due to each isotope will be

$$\frac{0.046}{1 \neq 1 \neq 0.046} = 0.0225 \text{ for } U_{235}$$

$$\frac{1}{1 \neq 1 \neq 0.046} = 0.4688$$
 for 0_{236}

and

$$A_{235} = \frac{0.0225}{0.00705} A^{\circ} = 3.19 A^{\circ}$$



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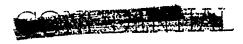
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The value of is to be determined by measuring a set of normal U.O. films in retation with the test samples to eliminate the effect of any change in the instrument used.

The weight fraction of v_{235} in the test films (w_{235}) can be determined to a fair degree of accuracy (L.E. 15). As a first approximation the weight fraction of v_{236} can be considered the entire remainder of the uranium. The first approximation (w_{234}) of w_{234} is then:

$$m_{234}^2 = \frac{1}{843010} \left[A - 3.194^{\circ} m_{235} - 0.492244^{\circ} (1 - m_{235}) \right]$$
 $m_{234}^2 = \frac{1}{8430} \left[\frac{A}{A^{\circ}} - 2.698 m_{235} - 0.49224 \right]$

Successive approximations are obtained by correcting the mass of U238 for

A537.

80

$$\frac{11}{234} = \frac{1}{8430} \left[\frac{1}{4} - 2.698 =_{235} - 0.49224 \left(1 - \frac{1}{234} \right) \right]$$

$$\frac{111}{234} = \frac{1}{8430} \left[\frac{1}{4} - 2.698 =_{235} - 0.49224 \left(1 - \frac{11}{234} \right) \right]$$

$$\frac{11}{234} - \frac{1}{234} = \frac{169224}{8430} = .600058 \text{ er } 0.0066$$

$$\frac{111}{234} - \frac{11}{234} = \frac{149224}{8430} = .600058 \text{ er } 0.0066$$

The second approximation adds but six thousandths of a parcent to the value of more and succeeding approximations each the same fraction of the presenting servation. As instrument errors will certainly be of the order of one tenth of a percent or more there is no gain in taking more than the second approximation. The value of more therefore considered sufficiently well expressed by all.

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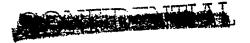
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The change in the value of m_{23L} resulting from a 1% increase in m_{238} (from fission count) is

 $=\frac{2.7}{8430}$ (0.01 \mathbf{z}_{235}) = - 0.0000032 \mathbf{z}_{235}

This represents a change of 0.039% in more for feed material. For top plant product the percentage change in most would be about 0.05% and at other points in the plant it should not exceed 0.05%. (These values for plant material are based on alpha counting experience with the "Steraberg Specials").

Errors in manh due to errors in the isotope raties for normal almost completely cancel out in taking the ratio for two test samples differing in consentration by no more than the separation factor of a single building. Ressonable errors in At (say 1%) likewise cancel almost completely in the ratio.

The alpha counting errors centribute to the error in the U234 enrichment etic in different degrees depending on the concentration. For top plant material Dalox change in the counting rate (A) of one of the test samples gives a change of & in the ratio. For feed material however, an equal change (0.10%) in A gives bange in the enrichment ratio. For material enriched 5.6 times (~45 Upre) a te in A gives a change of 0.125 in the enrichment ratio. At this enfinh-Mainting rate of the heaviest files (10 mg) is 21,000 counts per that line extrapolation of alpha counter results is not deemed valid above this.

> kfor the test samples (top and bottom of the isolated building) low 0.50% can reasonably be expected. The corresponding ant of U234 is below one percent. Longer than normal ed statistical analysis might improve the estimated

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